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# Splash-Locator for Visual Minewatching

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## Abstract

A splash locator for accurate visual observation of the splashes from air-dropped mines, modeled after the instrument detailed in British Admiralty reports, is described. Data are given from comparisons with radar- and photographically-determined locations of mine drops at Beavertail Point, Rhode Island, in the summer of 1953 indicating that as a minimum an accuracy of $1^{\circ}$ in the bearing at a range of 1,000 yards is possible. Because of the simplicity and cheapness of this method it is recommended that it be adopted as a "backer-upper" to radar surveillance of critical harbors and their approaches.

* * * * * * * * * * *

During the summer of 1953 some experience has been gained in the operation of a simple sighting instrument, modeled after the British Admiralty's Minewatching Instrument Mark I (ref. 1), to observe and record a bearing on the splash from an air-dropped mine. We have been impressed by the interest shown by the Admiralty in the perfection of this relatively simple and cheap device. As a physicist I have the greatest respect for radar, and I share the belief that properly designed radar equipment

should provide the best possible 24-hour surveillance of a harbor and its approaches for the tracking of enemy planes and the spotting of the splashes of any mines they drop. But there will be situations, both at our home harbors or at advanced harbors used by our forces, when effective radar observation is not available. Then visual splash spotting may be all that can be done, and a simple instrument to make these observations reasonably accurate should be manufactured in some quantity.

The scheduled drops of mines in connection with the operations of Beavertail Laboratory at the U. S. Naval Radar Facility at Jamestown, Rhode Island during the summer and early fall of 1953 presented an excellent opportunity to test the accuracy of visual splash spotting, for both photographic and radar observations were being made simultaneously on the same mine water entries. In addition, by having visual splash spotters operating at three suitably placed stations, an estimate of the accuracy was to be obtained from the magnitude of the failure of the subsequently plotted lines-of-sight to intersect at a common point. We were able to make good measurements under almost ideal conditions on 11 drops of Mk 39, Mk 36, and Mk 25 mines. No night observing was possible. My conclusions from this limited amount of

of work are in substantial agreement with the published reports of others (references 1-7). This is indeed an effective, if limited, method of splash spotting.

## Our Instrument

Figures 1 and 2 show clearly the essential features of the first model of our splash locator. The basic structure is just the front post and handle bars of a bicycle. We also use the hand trigger-cable mechanism of the bicycle to actuate a lever which presses the mark through a typewriter ribbon on to the calibrated paper chart. Comparison with the British reports will show that we have used many of their ideas, but we have not built a time-stamper into the device. Perhaps this feature should be included, for we have found it desirable for the three observers to record the time of each drop opposite the proper mark on the chart to avoid ambiguity when the drops occurred a few minutes apart. Suppose a string of mines is dropped at intervals of a few seconds!

The chin rest is essential. For long observation a seat should of course be provided. The sighting bar is 40 inches long, and we found it necessary to steady this bar with guy-wires. Also we increased the size of the

light metal cover over the ribbon spools so as to protect the ribbon and chart from wind and rain. Although our paper chart covers 180°, an observer should not be required to monitor a sector much greater than 90°. Fig. 3 is a reproduction of one of the charts showing the actual observations on four splashes and the bearings on three objects whose positions had been accurately surveyed-in on our maps. Inspection of Fig. 3 will convince the reader that the marks can be read to 1/10 degree, but we of course cannot claim that high an accuracy for each observation.

Since all of the observations I report were made with excellent daylight visibility, we adopted the British recommendation of using just one eye with both front- and near-sights in order to get the highest accuracy. It soon became clear to me, however, that the observer can have better surveillance of his area and almost as high accuracy if the front sight only is used with both eyes open. With the eyes focused on infinity, one then places the splash between the two images of the fore-sight and presses the trigger. To compare the accuracy of the two methods, a number of distant objects were sighted and recorded by both methods. The binocular method gave recordings agreeing to within ± 0.2° with

those using the one-eye squint, double-sight technique. We have also demonstrated that the accuracy of the binocular method can be further increased by lengthening the sighting bar another foot so that the two retinal images of the fore-sight are separated by a smaller but useable angle.

## The Observer Sites

All of these air-drops occurred in the west passage to Narragansett Bay sketched in Fig. 4. The grid coordinate squares as sketched are 500 meters on a side. Transit and movie camera mounts had already been constructed and surveyed-in at Beavertail Point, Prospect Hill and Fort Varnum. It was therefore logical to place our mounts (Fig. 1) at these same sites and to thereby share the telephone and radio circuits supplying information on the operations. These sites were in general good for our purposes, although some drops were made almost on the Fort Varnum-Prospect Hill line, making the angle of intersection of these two bearings on the splash about 180°, and hence lessening the accuracy of fixing the intersection point. The splash indicated in Fig. 4 is the No. 4 event on the chart in Fig. 3. The 3400-yard interval from Prospect Hill was about the

maximum observer-splash distance in our tests, but with the excellent visibility prevailing we could have operated easily up to three times this distance.

Regular installations should have huts built over these splash locators after the manner of our British colleagues. Their recommendations (reference 5) on the spacing of these stations (as close as every 400 yards, which might mean some platforms afloat) should be carefully studied. It is highly desirable that all the spotters be tied into a radio or telephone circuit so that they may receive information from radar that possible enemy planes are being tracked.

## Our Results

With the help of the surveying section at the Beavertail Laboratory, our instrument stations were accurately located on the 100-meter grid map (scale 320 meters per inch) of this area which had been produced by the U. S. Navy Hydrographic Office. This map shows our principal standard landmarks; the spire in Saunderstown, the tallest radar tower at the Radar Facility, Whale Rock in the West Passage, and the tower at Narragansett Pier. Angular differences between our chart readings and the bearings on these landmarks were then plotted with a

large protractor. In this plotting work it was obvious that by interpolating between the angular differences from charted bearings on two or three landmarks, increased accuracy results.

Table I contains the grid coordinates in meters of the eleven splashes recorded and plotted in the manner just described. For comparison I tabulate all the radar-located splash positions supplied to me by our radar sub-project and the splash positions determined by movie camera-transit observations from the same stations used by us. The radar-determined locations are subject to some error introduced in the calibration of their non-linear range indicator, and both their grid coordinates and ours are subject to the errors of plotting. These plotting errors can be considerable unless the greatest care is exercised.

In Table II are given the deviations of our visual splash locations from those found by the other two methods. The mean values of these deviations without regard to sign are given at the bottom of the table. The better agreement for the east-west coordinate probably results from the shape of the West Passage and the fact that the airplane runs were all made in a predominately northerly direction.

Table I. Grid Co-ordinates of the Splashes of Eleven Air-Dropped Mines at Beavertail Point, Rhode Island, Summer, 1953.

| Date and Event | Our Visual Location | Radar | Photographic |
|---|---|---|---|
| 13 Aug, No. 1 | N 4,591,420 meters | 4,591,435 | 4,591,415 |
| | E 0,298,375 meters | 0,298,375 | 0,298,380 |
| 13 Aug, No. 2 | N 4,591,708 meters | 4,591,710 | 4,591,690 |
| | E 0,298,620 meters | 0,298,610 | 0,298,620 |
| 2 Sept No. 1 | N 4,592,865 meters | 4,592,880 | 4,592,865 |
| | E 0,298,485 meters | 0,298,485 | 0,298,480 |
| 2 Sept No. 2 | N 4,591,580 meters | -- | 4,591,575 |
| | E 0,298,850 meters | -- | 0,298,840 |
| 3 Sept No. 1 | N 4,592,195 meters | 4,592,220 | 4,592,195 |
| | E 0,298,120 meters | 0,298,130 | 0,298,130 |
| 3 Sept No. 2 | N 4,592,377 meters | 4,592,390 | 4,592,370 |
| | E 0,298,265 meters | 0,298,250 | 0,298,255 |
| 9 Sept No. 1 | N 4,592,195 meters | -- | 4,592,180 |
| | E 0,299,000 meters | -- | 0,298,990 |
| 9 Sept No. 2 | N 4,592,480 meters | -- | 4,592,465 |
| | E 0,299,030 meters | -- | 0,299,035 |
| 9 Sept No. 3 | N 4,591,985 meters | 4,591,965 | 4,591,985 |
| | E 0,298,250 meters | 0,298,260 | 0,298,240 |
| 9 Sept No. 4 | N 4,592,055 meters | 4,592,090 | 4,592,045 |
| | E 0,298,220 meters | 0,298,220 | 0,298,210 |
| 9 Sept No. 5 | N 4,592,335 meters | 4,592,345 | 4,592,320 |
| | E 0,298,180 meters | 0,298,180 | 0,298,180 |

Table II. Deviations of our Visual Splash Locations from those Found by:

| | | Radar | Photographic |
|---|---|---|---|
| 13 August, No. 1 | N: | 15 meters south | 5 meters north |
| | E: | 0 | 5 meters west |
| 13 August, No. 2 | N: | 2 meters south | 18 meters north |
| | E: | 10 meters east | 0 |
| 2 Sept, No. 1 | N: | 15 meters south | 0 |
| | E: | 0 | 5 meters east |
| 2 Sept, No. 2 | | -- | 5 meters north |
| | | -- | 10 meters east |
| 3 Sept, No. 1 | N: | 25 meters south | 0 |
| | E: | 10 meters west | 10 meters west |
| 3 Sept, No. 2 | N: | 13 meters south | 7 meters north |
| | E: | 15 meters east | 10 meters east |
| 9 Sept, No. 1 | | -- | 15 meters north |
| | | -- | 10 meters east |
| 9 Sept, No. 2 | | -- | 15 meters north |
| | | -- | 5 meters west |
| 9 Sept, No. 3 | N: | 20 meters north | 0 |
| | E: | 10 meters west | 10 meters east |
| 9 Sept, No. 4 | N: | 35 meters south | 10 meters north |
| | E: | 0 | 10 meters east |
| 9 Sept, No. 5 | N: | 10 meters south | 15 meters north |
| | E: | 0 | 0 |
| Mean Deviations without regard to sign: | N: | 17 meters | N: 8 meters |
| | E: | 6 meters | E: 7 meters |

## Conclusions

Judging from the magnitudes of these discrepancies between these three methods of splash location, I would say that with care and under good conditions one can improve somewhat on the estimate of O. L. Hay (reference 7) that the visual splash locator can spot the splash to within $1^{\circ}$ at 1000 yards range. Under just fair observing conditions, however, and with only average observers I would be inclined to agree with Mr. Hay's estimate of the accuracy of this visual method. But the method is so simple and cheap, and since the operators can be women, old people, 4 F's, etc., with very little training, I strongly recommend that suitable visual splash locators be manufactured in quantities and that they be distributed with an operation manual written in a simple, direct style. A standard mine-watchers hut should be designed and good attention should be paid to the recommendations of the British who are ahead of us in this basically simple defense measure.

I wish to acknowledge the valuable assistance of W. Phelps, F. Barone and R. Wilde who worked enthusiastically on both the construction and observation phases of this investigation.

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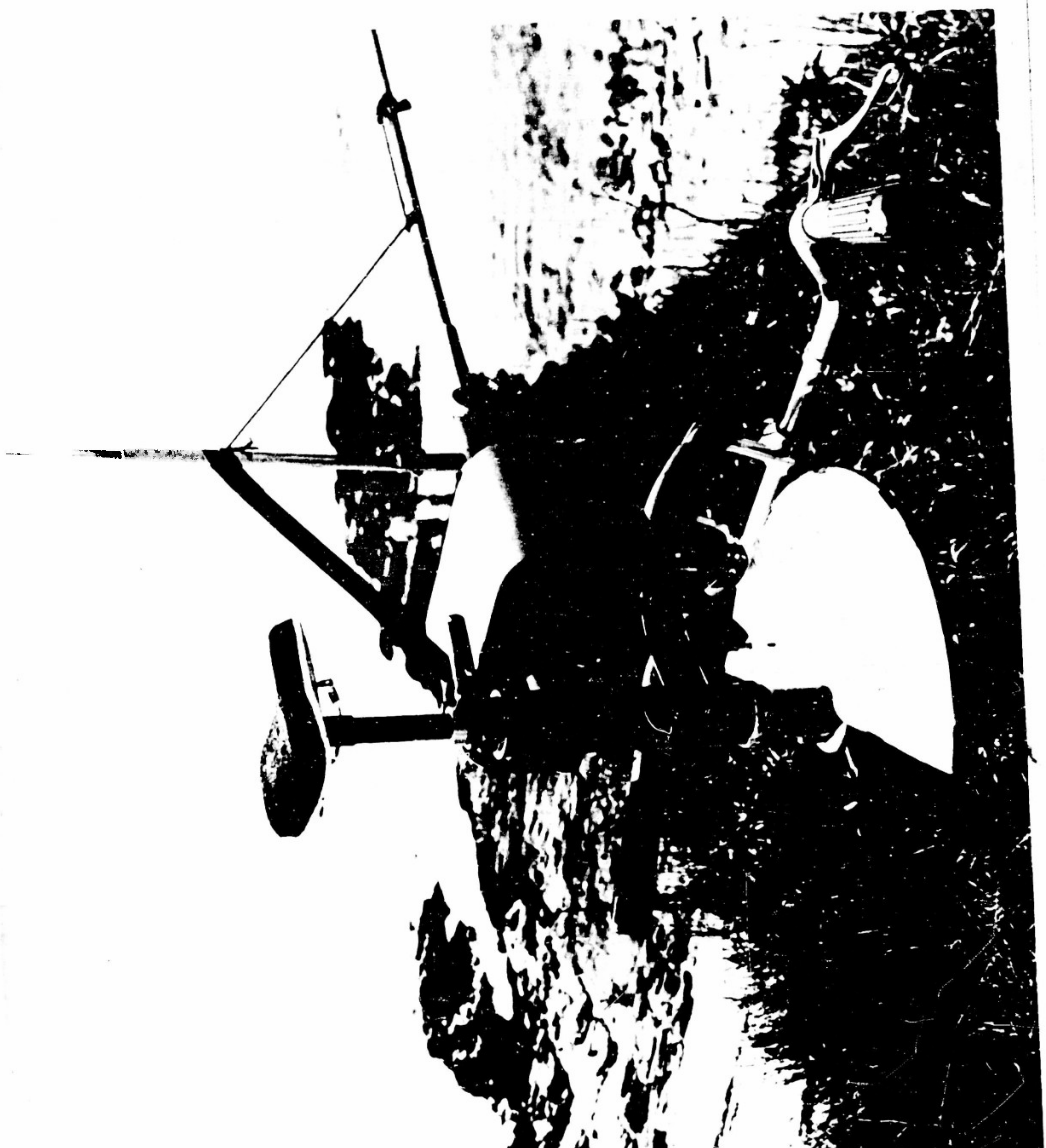

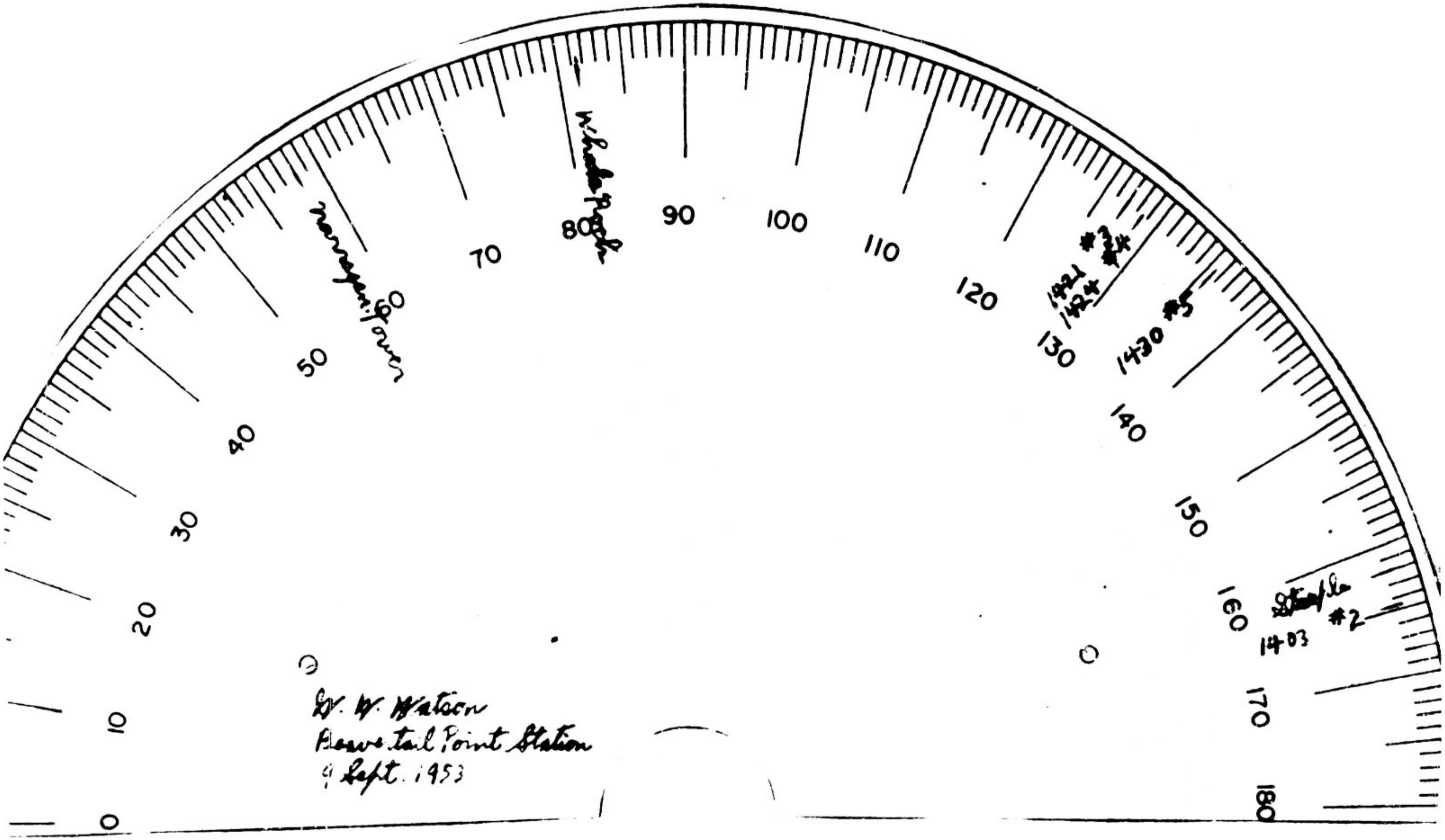
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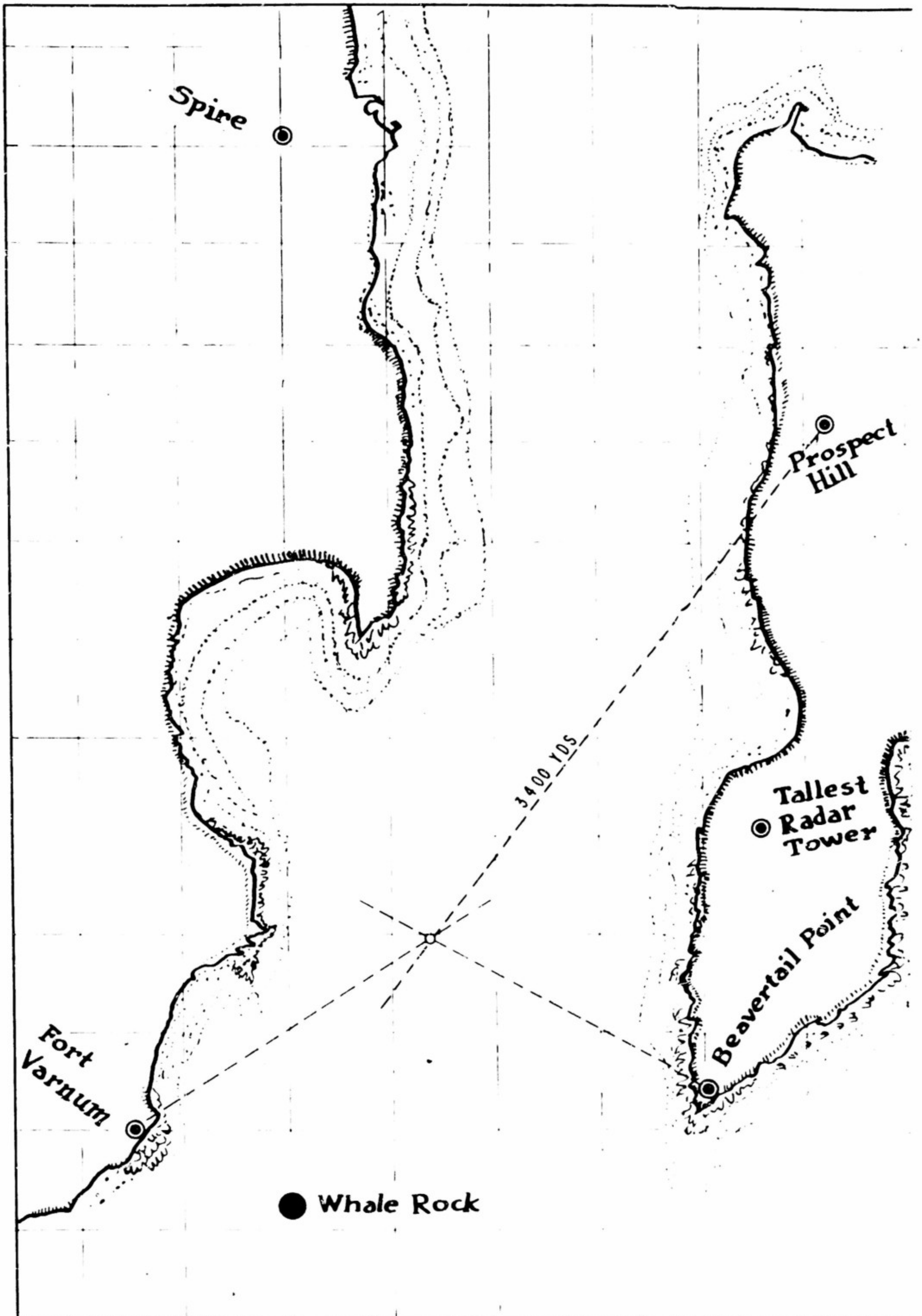
Narragan. Tower
Whale Rock
1421 #3
1424 #4
1430 #5
Steeple
1403 #2
G. W. Watson
Beavertail Point Station
9 Sept. 1953

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